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RESEARCH ARTICLE

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Understanding Yurok traditional ecological knowledge and wildlife management

Seafha C. Ramos

School of Natural Resources and the Environment, The University of Arizona, Tucson, AZ 85721, USA

Correspondence
Seafha C. Ramos, Department of Wildlife, Humboldt State University, 1 Harpst Street, Arcata, CA 95521, USA.
Email: seafha@gmail.com

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Abstract

Indigenous communities have often been marginalized in the sciences through research approaches that are not inclusive of their cultures and histories. The term traditional ecological knowledge (TEK) has entered the discourse in wildlife management and conservation; however, there can be challenges in cross-cultural communication and conceptualizations of TEK when working between Western and Indigenous paradigms. Indigenous research methodologies (IRM) is an area of scholarship intended to build ethically and culturally appropriate ways to conduct research with Indigenous communities. I implemented 7 tenets of IRM in research to explore the conceptualization of TEK and wildlife management with the Yurok Tribe of California, USA. After conducting semi-structured interviews with 20 Yurok community members from 2011 to 2013, I conducted emergent analysis and present 5 themes from the interviews related to phases of time, the conceptualization of Yurok TEK, and views on wildlife management through the Yurok cultural lens. This research may be helpful to wildlife biologists, students, academics, and others who are interested in IRM and culturally sensitive wildlife research with Indigenous communities. By bridging concepts from Indigenous studies, wildlife management, and human dimensions of wildlife, this work may serve as a nascent trajectory that creates more inclusive space for Indigenous peoples and worldviews in The Wildlife Society and other scientific disciplines.

KEYWORDS

human dimensions of wildlife, Indigenous research methodologies, traditional ecological knowledge, wildlife conservation, wildlife management, Yurok Tribe

Interest in traditional ecological knowledge (TEK) is growing in applied ecology and natural resource management fields, partly because of a recognition that TEK can contribute to the conservation of biodiversity, rare species, and ecological processes (Mazzocchi 2008, Bird et al. 2012). Traditional ecological knowledge research has been conducted in wildlife management, conservation, and human dimensions in a variety of contexts and geographical locations, including studies with moose (*Alces alces*; Darimont et al. 2005) and woodland caribou (*Rangifer tarandus caribou*; Polfus et al. 2014) in British Columbia, Canada, polar bears (*Ursus maritimus*) in Nunavut, Canada (Dowsley and Wenzel 2008), subsistence hunting on the Lac du Flambeau Indian Reservation in Wisconsin, USA (Reo and Whyte 2012), and elsewhere (Learn 2020).

The term TEK was coined in Western academia, not from Indigenous communities (McGregor 2005), and even within academia it has no universally accepted definition (Mazzocchi 2008). Traditional ecological knowledge has been defined as, "a cumulative body of knowledge, practice and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment" (Berkes 2012: 7). It has also been defined as, "…the culturally and spiritually based way in which indigenous peoples relate to their ecosystems" (LaDuke 1994: 127). The academic field of TEK is intended to describe Indigenous paradigms, yet it is often expressed through a Western lens, in Western terminology (Mazzocchi 2008). For many Indigenous peoples, TEK encompasses such information, centered from their cosmologies and cultural frameworks, and denotes a system of responsibilities in active participation of natural resource management (Whyte 2013). Indigenous scholars have noted that TEK is not just knowledge about the relationships with the environment, but it is the relationship itself; it is the way that one relates. One lives TEK (McGregor 2004).

Approaches to TEK research have been influenced by divergent interpretations of TEK between Western and Indigenous scholars and scientists (Whyte 2013, Ramos 2018). The practical value of TEK is now widely established in the scientific discourse; Western and Indigenous knowledges have been used together to monitor and enhance wildlife habitat and populations. However, these paradigms are rooted in different philosophies (Moller et al. 2004, Senos et al. 2006, Ramos 2018). Further, unequal political power structures in decision making exist between Indigenous communities and natural resource management bureaucracies (Nadasdy 1999). One common approach, termed distillation, to TEK research is to treat TEK as an applied science by engaging Indigenous communities only to seek data (e.g., local knowledge of land and animals; biological information). This information is then integrated into existing management structures that benefit and conform to Western science (Nadasdy 1999, Roth 2004, Dowsley and Wenzel 2008). Distillation might be considered more exploitative than collaborative, perceived as removing TEK from Indigenous cultural contexts (Nadasdy 1999).

There is a need to understand Indigenous practices as part of culture. The importance of the social and cultural frameworks in which TEK is rooted is not as well established in the scientific literature (Mazzocchi 2008), with little emphasis placed on exploring Indigenous knowledge within its cultural and spiritual context (Agpar et al. 2015). The traditional belief systems of tribal communities are arguably the most misunderstood aspect of TEK and deserve more attention (Reo 2011). Culture creates the social lenses through which people see the world. If culture is understood as an expression of values, beliefs, and norms that define how a society represents itself and what it sees as important, it also influences the way the society thinks about and relates to the environment (Lyon and Parkins 2013).

There is value in understanding and promoting diverse cultural foundations and social dimensions of ecosystem management (Folke 2004). For example, researchers working with Guna peoples in Panama have illustrated the importance of considering cultural and spiritual dimensions of social-ecological resilience and how inductive, qualitative research methods can provide rigorous scientific insights (Agpar et al. 2015). In tribal communities, deep content expertise, local field knowledge, knowledge of spiritual traditions, and ethical knowledge are embodied in TEK holders. Ethical or spiritual dimensions such as traditional values and the nature of human-animal relations, however, are commonly ignored when TEK is taken out of its cultural context (Reo 2011).

Integrative research is needed that transcends disciplinary boundaries and embraces ideas from the natural and social sciences so that a wider range of practices, tools, and knowledge can be mobilized (Roth 2004, Stone-Jovicich et al. 2018). As it is likely that much of wildlife management will have a cross-cultural element in the future (Manfredo 2008), it will be important to explore approaches to TEK and wildlife research with Indigenous communities in a culturally sensitive manner (Ramos 2018). The pursuit of TEK research may serve as a fruitful foundation for cross-cultural and collaborative understanding (Whyte 2013). In this vein, it might be useful to consider the use of Indigenous research methodologies (IRM) in TEK and wildlife research with Indigenous communities (Ramos 2018).

Indigenous research methodologies

Because Western academic institutions and scientific disciplines have marginalized Indigenous histories and present-day narratives, there is a need for research that employs a range of methodological options determined by the needs of Indigenous communities. Some Indigenous scholars have worked to challenge the promotion of Western knowledge systems at the expense of those of Indigenous communities (Johnson 2016). As Indigenous peoples have grasped for the ability to represent themselves through their own narratives and intellectual traditions, we have witnessed a shift in the academic landscape as studies move to construct new, mutual forms of dialogue, research, theory, and action (Kovach 2016). Indigenous peoples have advocated for their own value systems, traditional governance, and ways of life in relation to the cosmos and the environment (Johnson 2016). Aligning with this advocacy, Indigenous scholars state that research conducted among Indigenous communities should respect their worldviews and forms of government, community, and culture (Champagne 2015).

Indigenous research methodologies is a scholarly field related to decolonizing methodologies (Smith 2012, Chalmers 2017) and is suggested as a potential avenue toward culturally sensitive TEK research in wildlife conservation (Ramos 2018). Concerned with ethically and culturally appropriate ways to conduct research with, rather than on, Indigenous communities (Lavallee 2009), IRMs are not theoretically constructed but conform to Indigenous ethical protocols that shape methods according to local cultural imperatives (Porsanger 2004). Indigenous research methodologies may incorporate Indigenous knowledge systems (Johnson 2016). Relational accountability—researchers making themselves accountable to the research itself and the community they are working with—and use of methods that align with an Indigenous paradigm are foundational aspects of IRM (Wilson 2008, Kovach 2016). Approaches to research through IRM will actualize differently based on the given location in time and place, and the intentions of the researcher (Chalmers 2017).

Throughout this paper, I use the term Indian when referring to standard terminology as applied in United States Federal Indian Law, Tribe to signify government-level organization of a tribal community and the term Indigenous to refer to peoples and communities generally. This paper is intended for current and upcoming wildlife management and conservation professionals, professors in wildlife and other natural resources fields, and those interested in collaboration between Indigenous communities, universities, agencies, and other partners. Further, the material presented may be important to federal agencies in working toward fulfillment of federal trust responsibilities to Tribes.

Positionality

Nek 'n-ew Seafha. 'Ne-kuechos 'w-ew Donna Martin ('aawok); 'ne-chek 'w-ew Marion Frye; 'ne-psech 'w-ew José Ramos; 'ne-nos 'w-ew Gary (Bear wegenee'); 'ne-me'yp'or Ponchess esee Allie Wohpueneeka'. 'Ernerr', Ahpah, 'esee Wechpues me'womechook'. In alignment with an Indigenous research paradigm (Wilson 2008), I introduce myself and address

my intentions with this work. I am Yurok and Karuk from my mother and have participated in Indigenous cultural activities throughout my life. I have been most involved with Yurok culture; a cultural norm in that community is to introduce oneself by stating the family and village(s) from which one descends. I come from the Frye family and the villages of 'Ernerr' (Blue Creek), Ahpah, and Weitchpec.

Through my academic and professional experience in wildlife conservation (much of which is grounded in Western science) and my understanding of TEK based on my lived experience, I recognize that there is opportunity to better integrate these worldviews in the wildlife profession and academic programs in Western-based institutions. This research is congruent with my desire to conduct academic-based wildlife research that integrates aspects from Indigenous and Western science philosophy and methods. Indigenous research methodologies were incorporated into this study to facilitate a culturally sensitive approach to this work that built respectful relationships between participants and me, emphasized my obligations and responsibilities to the participants and the community, and emphasized the reciprocity of sharing, learning, and growth.

The first objective of the present research is to apply IRM in a human dimensions of wildlife study with the Yurok Tribe of California, USA, the state's largest federally recognized Tribe (Constitution of the Yurok Tribe 1993), with more than 5,000 enrolled members (Yurok Tribe 2021). The second objective is to understand how TEK and the relationship between wildlife management and TEK may be conceptualized through the Yurok cultural lens. I conclude with discussion on how this framework can be applied by wildlife and natural resources professionals working in collaboration with Indigenous communities. I present detailed research that includes human dimensions of wildlife, history, Indigenous studies, and other disciplines that may otherwise seem disparate. I provide extensive detail rather than a general exhortation, conveying a comprehensive example of research in collaboration with a Tribe that may be applied in other regions. Gaining better understanding of the material presented might serve to facilitate culturally sensitive wildlife conservation and management practices.

STUDY AREA

The present study took place from 2010 to 2013 with the Yurok tribal community located in northwestern California. Yurok ancestral lands are centered on the Klamath River where it meets the Pacific Ocean, covering more than 161,874 ha (Figure 1; Huntsinger and Diekmann 2010). The climate of the region has wet, cool winters (Dec–Feb) and mild, dry summers (Jun–Aug). Coastal fog occurs throughout the year (Starns et al. 2015). Average annual precipitation varies from approximately 1,200 mm to 1,800 mm and occurs mostly as rain; 90% of this precipitation falls between the months of October and April. Mean summer temperatures range from 24°C to 27°C and mean winter temperatures range from 3°C to 5°C (Kolbe and Weckerly 2015). Elevation ranges from 0 to 1,805 m (S. Chase, Yurok Tribe Geospatial Information Technology Program, personal communication).

The landscape is composed of meadows, oak (*Quercus* spp.) woodlands, and second-growth and old-growth redwood-conifer stands that are dominated by coast redwood (*Keehl*; *Sequoia sempervirens*), and Douglas-fir (*Tepoo*; *Pseudotsuga menziesii*; Weckerly and Ricca 2000, Kolbe and Weckerly 2015). Some important fauna for the Yurok include mule deer (*Puuek*; *Odocoileus hemionus*), elk (*Meyweehl*; *Cervus canadensis roosevelti*), river otter (*Nepe'weeshneg*; *Lontra canadensis*), sea otter (*Wohpueneeka'*; *Enhydra lutris*), sea lion (*'Echkwoh*; *Zalophus californianus*), green sturgeon (*Kahkah*; *Acipenser medirostris*), and Pacific lamprey (*Ke'ween*; *Lampetra tridentata*). Some flora important to the Yurok include redwood, tanoak (*Ho'mono'*; *Notholithocarpus densiflorus*), hazel (*Holeehl*; *Corylus cornuta*), pepperwood (*Wohkelo'*; *Umbellularia californica*), and seaweed (*Chege'l*; *Porphyra* spp.; Constitution of the Yurok Tribe 1993).

In 1993, the Yurok Tribe organized its government and constitution based on several objectives, including to, "Preserve and promote our culture, language, and religious beliefs and practices, and pass them on to our children…" and "Restore, enhance, and manage the tribal fishery, tribal water rights, tribal forests, and all other natural

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FIGURE 1 Interviews regarding traditional ecological knowledge (TEK) took place with the Yurok community (2011–2013). Yurok ancestral lands are located in northwestern California, USA, with the Yurok reservation centering on the Klamath River from the estuary near Klamath, extending inland to Weitchpec. Map courtesy of Yurok Tribe Geospatial Information Technology Program

resources" (Constitution of the Yurok Tribe 1993: 3). Because of myriad laws, policies, and historical events, there have been many changes to the vegetation structure of the landscape since European settlement (Huntsinger and Diekmann 2010). Further, many aspects of Yurok culture were negatively affected when Federal laws and policies outlawed the practice of Indigenous customs (Buckley 2002). Many people have strived to revitalize Yurok cultural practices, including ceremony and language. Today, many Yurok people continue to serve as advocates for the community, the environment, and cultural survival (Lara-Cooper and Lara 2019, Ramos 2019).

METHODS

Research design and sampling

I applied 7 tenets of IRM: 1) follow tribal protocols, such as tribal Institutional Review Board processes; 2) intentionally build community capacity through the research agenda; 3) facilitate community ownership of data; 4) build a relationship with the community that is long-term; 5) consider potential impacts of historical events due to settler colonialism and how the research empowers the community; 6) give back to the community, such as in bringing back new knowledge or taking the needs of the people into account when formulating the research agenda; and 7) distribute research results and outcomes in an appropriate and meaningful way (i.e., more than just sending a copy of the final written product). These tenets are a subset of IRM themes from published literature (Lambert 2014, Kovach 2016).

To develop culturally sensitive interview methodology, I used a methods resource specifically for oral history projects with Indigenous communities (Trimble et al. 2008). I consulted with the Yurok Tribe Heritage Preservation Officer, IRB informed consent documentation, and the research protocol to develop the interview question and topic guide. I consulted with the Yurok Tribe Culture Committee and Yurok Tribe Natural Resources Committee throughout the research process. Additionally, I met with the Yurok Tribal Council upon my initial consideration to pursue research in natural resources with the Tribe to ask if such a pursuit would be supported (2009). Upon the support of the Tribal Council, I later requested meetings to discuss general research ideas and refine my research proposal (2010). The Yurok Tribal Council assessed and approved all interview materials prior to research initiation and provided a support letter in the IRB process (2010–2013). Following the Yurok Tribe's protocols aligns with IRM tenet 1 (Table 1). The question and topic guide included 8 sections:

1. If you hunted growing up, please, describe a typical hunting trip. Discuss your role, if you have one, if anyone in your family hunts or used to hunt.
2. Do you think values of Yurok people toward wildlife have changed over time?
3. Distinguish between which animals are used for food or ceremony. Should they be managed differently?
4. Are there any cultural guidelines for taking wildlife (e.g., hunting)? If so, what happens if someone does not follow those guidelines (e.g., consequences)?
5. How did/do the Yurok interact with wildlife (food, spiritual guidance, medicine, etc.)?
6. What does "traditional ecological knowledge" mean to you?
7. What are your personal views and values towards animals (protection, etc.)?
8. What are the foundations of the Yurok-Wildlife relationship?

To capture the context of each participant's viewpoint and experiences, it was necessary to use methods that adequately allowed them to freely express themselves rather than check off responses that may not represent the depth and breadth of their sentiments. Further, the objective was to gain a deeper understanding of concepts from a Yurok cultural lens rather than generalizations across the entire Yurok tribal membership. Therefore, I conducted semi-structured interviews with open-ended questions, which can provide detail, depth, and an insider's

TABLE 1 Tenets of Indigenous research methodologies (IRM) and actions of implementation in research with the Yurok Tribe and tribal community, Yurok ancestral lands, California, USA, 2011–2013

IRM tenet number	IRM tenet description	Implementation
1	Follow Tribal protocols	In addition to requesting a letter from the Tribal Council per the university Institutional Review Board process, I further implemented tenet 1 by meeting with tribal committees and following their guidance. Other examples include following cultural protocols in the field as instructed by the Yurok Culture Committee and providing gifts of traditional foods to interview participants. Researchers who are not members of a tribal community should consider investing time with a community to learn if there are specific cultural protocols that should be followed.
2	Research agenda should intentionally build community capacity	I worked closely with a staff member of the Yurok Tribe Wildlife Program, who is also a Yurok Tribal member, to discuss emergent themes and initial drafts of this paper for consideration and implementation by the Tribe.
3	Take care that the community owns data	Community members had the option to keep a copy of their interview transcript and donate their interview transcript to the Yurok Tribe.
4	Build a relationship with the community that is long-term	I attended public and cultural events for years before I considered conducting this research. Throughout the research process, I maintained contact with interview participants, such as in the process of member checking. I continue to be involved with the community many years beyond project completion.
5	Research empowers the community	This research brings forward voice of a marginalized group in The Wildlife Society. By creating space for Indigenous voice through culturally sensitive methods such as IRM, we empower not only the Yurok community, but also other tribal communities, researchers, and our future Indigenous wildlife professionals.
6	Give back to the community	The results of this research were used in the development of a set of elementary school science lessons that includes traditional ecological knowledge and a simulated wildlife track and scat activity (Ramos et al. 2020).
7	Distribution of research results and outcomes in an appropriate and meaningful way	I delivered a presentation of this research to community members. The implementation of tenet 6 could also be considered as appropriate for tenet 7.

perspective (Leech 2002). This method has been used successfully in TEK studies with Alaska Native communities; it allows the participant and the researcher to guide the interview, and in group interviews allows participants to validate each other (Huntington 1998, 2000).

To identify initial interview participants, I consulted the Yurok Culture Committee, Yurok Natural Resources Committee, and Yurok community members. After conducting each interview, I used the chain referral method (Heckathorn 2011) to identify additional potential participants. I included people over the age of 18 who were of

Yurok ancestry or who were Yurok-affiliated, meaning they were not of Yurok ancestry but were identified as knowledgeable about relationships among wildlife, natural resources, and Yurok culture. Twenty people were included in this study; however, I conducted 16 interviews because some people participated in groups.

Interview procedures and analyses

During informed consent, each participant opted to be identified by their actual name rather than a pseudonym. To provide an avenue for preservation and transmission of information, I gave participants the option to receive a copy of their interview transcript and donate a copy to the Yurok Tribe. Providing these options for community and Tribal ownership of data aligns with IRM tenet 3 (Table 1). I documented each participant's name, age category (young adult = 18–35 yr; adult = 36–55 yr; elder ≥56 yr), tribal affiliation(s), tribal village(s), and livelihood or occupation. I digitally recorded each interview, video or audio, according to the preference of the participants. I provided a copy of the 10-question interview guide for this research to each potential participant and offered them time to formulate their thoughts to decide whether to be included in the study. If a participant was not familiar with the term TEK, I provided a brief description based on the scientific literature. I described TEK as a scholarly field related to the knowledge, practices, and beliefs in Indigenous communities about the environment and relationship with the environment, passed down from generation to generation. I then explained that the purpose of this research is to understand TEK through the Yurok cultural lens; I asked participants what TEK means to them and how they would describe TEK from a Yurok perspective. Included in the interview guide were questions regarding conceptualizations of TEK and wildlife and aspects of the Yurok-wildlife relationship. Following interviews, I gave each participant either *cheeek* (contemporary currency) or culturally appropriate items such as traditional foods. I began preparing some of the traditional foods, such as gathering acorns for acorn flour, a year in advance of interviews because of the processing time required. Providing gifts of traditional foods aligns with IRM tenets 1 and 4 (Table 1).

I assigned a unique code for each participant (P) and a number. I then transcribed each recording and edited the transcripts such that I used a code in place of actual names. I conducted manual and thematic coding with extensive use of notetaking throughout. Initially, I printed each transcript and read it in its entirety to gain a sense of the participant's responses. I then manually conducted the first round of coding where I highlighted passages and noted potential themes and categories (Seidman 2006). I used NVivo (version 11, QSR International, Burlington, MA, USA) software to code the transcripts electronically and complete the analyses. To assess ideas and themes that emerged relevant to the research aims, I reviewed passages of a subset of pertinent codes. I sought to explicate the lived experiences and knowledge of the participants, coalescing in the contextualization of TEK from a community perspective.

In reporting results, I edited quotes for clarity. Because of the subjective nature of interview-based qualitative methods, I employed member checking; I provided participants their interview transcript and drafts of the manuscript for an opportunity to determine whether quotes or summaries accurately represented their perspective and to verify the intent and meaning of statements (Carlson 2010). Member checking aligns with IRM tenet 4 (Table 1) because it allowed the continuance of personal connections after I conducted the interviews. In this process, 2 participants noted their preference that quotes in the resulting publication be associated with participant identification codes rather than actual names.

RESULTS

There were 5 young adults (2 males, 3 females), 3 adults (all female), and 12 elders (8 males, 4 females) included in this study; 19 participants were of Yurok ancestry and 1 participant was not Yurok but was of Hupa (a neighboring Tribe) descent and married to a Yurok. Participants included spiritual and cultural leaders, medicine women and

men, Yurok Tribe government officials, Yurok Tribe Cultural Resources staff, Yurok Tribe Natural Resources Committee appointees, Yurok Tribe Culture Committee appointees, a fishing guide, Yurok Tribe Language Program staff, a nurse, a college student, and a Hoopa Valley Tribe culture committee member. While most participants listed 1 of the above categories, some listed up to 3 (Table 2).

I report themes that participants explicitly stated as important or that emerged during analysis illuminating the Yurok worldview and cultural framework as related to TEK and opinions regarding wildlife management and Yurok culture. Themes include the desire to share and for others to learn about Yurok culture (i.e., knowledge sharing), Yurok phases of time, conceptualization of Yurok TEK, and views surrounding wildlife management.

Knowledge sharing

Although none of the interview questions explicitly addressed knowledge sharing, over half of the interviews contained references to the desire for people within and outside of the Yurok community to learn about various aspects of the Yurok worldview. Some participants said they chose to be interviewed as an opportunity to contribute to the continuance of Yurok culture. There is a desire to preserve the information from the interviews and use it for educational purposes, as sometimes Yurok people might not know cultural teachings. There is a strong desire, indicated by phrases such as, "People really need to learn that," for Yurok people to understand the importance of wildlife in the Yurok culture and the beliefs and values in Yurok-wildlife relationships. Teaching Yurok people these cultural aspects may strengthen connections to culture, the environment, and wildlife. Some participants noted the recording of TEK might allow tribal and non-tribal people to understand Yurok customary law and traditional natural resources management, potentially benefitting relationships between the Tribe and agencies. Participant 4 noted that it seems agency personnel often struggle with the uniqueness of Tribes and there is a tendency to seek blanket approaches to working with Tribes. Learning about unique aspects of the Tribes agency personnel are working with might facilitate cultural sensitivity.

Concerns about sharing information that will be available to the broader public were shared by 2 participants. Participant 6 noted that there have been situations where information, such as mapping of certain locations, has been accessed to the detriment of Yurok people, though they did not discuss details of such events. Participant 16 expressed that there is consideration in what is shared and what is held back because there is, "always a possibility of misleading…when you start writing things, you get control. People start changing things and meanings and the purpose of things. We always try to avoid that."

Yurok phases of time

Participants noted chronological changes explicitly. Participant 19 noted, "When you look at our relationship with the natural environment, you have to look at it in different phases." Overall, 5 major time periods emerged during the interviews. The first pertains to the Yurok creation story when all beings were in spirit form. Participant 4 stated, "There are stories about pre-human times, in the *'woogey* times… animals used to be part of our lives and communicate with us, and they were people, basically." Yurok people in physical form are considered to have lived in the local area since time immemorial. Some participants used the term "old ways" to characterize what I interpret as pre-European contact, or the second time period. Participant 3 said, "…what I used to hear all the time was *heekon*, and that was from my mother's mother…the *heekon oohl*. That's an old-time person."

The third time period was early contact, which begins when westward expansion of European settlers reached northern California. Non-Indians began settling in Yurok country during the gold rush of 1849 (Buckley 2002). On a national level, while the wildlife profession was emerging in the 1930s from efforts in game management, federal policy was enacted to move Indians onto reservations and forcefully assimilate them (Ramos 2018). The State of

TABLE 2 Interview participant (n = 20) names, tribal affiliations, tribal villages, and biographical accounts as self-disclosed at the time of interview regarding Yurok traditional ecological knowledge and wildlife management, Yurok ancestral lands, California, USA, 2011–2013. *'Aawok* is used as a respectful way to acknowledge someone as deceased at the time of publication of this paper

Name	Tribal affiliation(s)	Village(s)-Yurok, unless otherwise noted	Brief biographical account at the time of interview
Pergish Carlson	Yurok	'Ernerr', Pecwan	Raised hunting, fishing, and participating in ceremony. Owns a fishing guide business, specializing in fishing on the Klamath River in Yurok ancestral territory.
Victoria Carlson	Yurok, Tolowa	Sregon, Ke'pel	Raised participating in Yurok and Tolowa ceremony. Is a college student and a Yurok language specialist.
Margarite Carlson ('*Aawok*)	Yurok	Ahpah, 'Ernerr', Pecwan	Raised gathering and preparing traditional foods and medicines for subsistence. She was raised with elders, learning Yurok language throughout her childhood.
Rosie M. Clayburn	Yurok	Turip	Employed as the Yurok Tribe Cultural Resources Manager. Participates in Yurok ceremony.
Kishan Lara-Cooper	Yurok, Karuk, Hupa	Espew, Chahpekw, Morek Hupa: Mèdil ding, Ts'welnaldin Karuk: Chimikiniinaach (Jelo ding in Hupa language)	Employed as an assistant professor at Humboldt State University in Arcata, CA. Participates in Yurok ceremony.
Marion Frye	Yurok, Karuk	'Ernerr', Ahpah, Wechpues	Raised gathering and preparing basket materials and traditional subsistence foods with her family.
James Gensaw	Yurok, Tolowa, Chetco	Rekwoy, Starwin, Pecwan	Employed at Yurok Tribe Language Program. Participates in Yurok ceremony.
Rebecca "Becky" James ('*Aawok*)	Yurok	Sregon	Raised preparing traditional foods. Participates in Yurok ceremony.
Patti James	Yurok	Sregon	Raised preparing traditional foods. Participates in Yurok ceremony.
Noreen Jones	Yurok	Sregon, Ke'pel, Pecwan, 'Ernerr'	Employed as a nurse. Raised preparing traditional foods. Participates in Yurok ceremony.
Frank Lara ('*Aawok*)	Yurok	Espew, Morek	Raised gathering and preparing traditional foods. Serves on Yurok Tribe Native American Graves Protection and Repatriation Committee and Yurok Tribe Culture Committee.
Walt "Black Snake" Lara	Yurok	Morek, Pecwan, Chahpekw, Espew, Oreqw	Formerly served on Yurok Culture Committee and Yurok Natural Resources Committee. United States veteran. Participates in Yurok ceremony.

TABLE 2 (Continued)

Name	Tribal affiliation(s)	Village(s)-Yurok, unless otherwise noted	Brief biographical account at the time of interview
Callie Lara	Hupa, Karuk	Hupa: Mèdil ding, Ts'welnaldin. Karuk: Chimikiniinaach (Jelo ding in Hupa language)	Serves on Hupa Culture Committee. Participates in ceremony among Hupa, Yurok, and Karuk.
Richard "Dickie" Myers	Yurok, Karuk	Sregon	Serves on Yurok Tribal Council. United States veteran. Participates in Yurok ceremony.
Robert McConnell	Yurok, Karuk	Wausek Karuk: Ameekyáaraam.	Raised hunting. Serves as Yurok Tribe Heritage Preservation Officer and Yurok Culture Committee coordinator. Participates in Yurok ceremony.
Allen C. McCovey (*'Aawok*)	Yurok, Tolowa, Chetco	Notchko heekoh	Serves on Yurok Culture Committee, Yurok Natural Resources Committee, and Yurok Tribe Native American Graves Protection and Repatriation Act Committee.
Barbara McQuillen	Yurok	Turip	Raised gathering traditional foods. Employed in the Yurok Tribe Language Program. Involved in Yurok ceremony.
Christopher Peters	Pueleeklaa (Yurok), Karuk	Waasay	Administrator at the Seventh Generation Fund for Indigenous Peoples in Arcata, CA. Participates in Yurok ceremony.
Lawrence "Tiger" O'Rourke	Yurok	Morek	Raised in the Yurok culture and formerly employed by the Yurok Tribe. Participates in ceremony among the Yurok and Karuk.
Thomas O'Rourke	Yurok	Morek, Pecwan	Serves as Yurok Tribal Chair. Participates in Yurok ceremony.

California passed several laws and policies during early contact that affected Indians. For example, the 1850 Act for the Government and Protection of Indians provided for indenturing Indians to Whites. A White person could assume care, custody, control, and earnings of a selected Indian minor or adult. Under California militia laws, 1851–1859, "Expeditions against the Indians" were organized. Militias were allowed to equip themselves in the same manner as the army of the United States and were reimbursed by the federal government. California Governor Peter H. Burnett noted in 1851, "That a war of extermination will continue to be waged between the races, until the Indian race becomes extinct, must be expected" (Johnston-Dodds 2002: 15).

Participant 14 said this time period was during their mother's generation and noted, "…the government tried to break our culture." Children were sent to boarding schools where they were scolded for practicing their culture, resulting in loss of knowledge. Participant 20 noted, "We were taught to be ashamed of our nationality, not to pray, not to speak our own language." Participant 19 explained that there was a lapse in ceremonies being held regularly because of the genocide that was taking place. Some ceremonies were held in secret, but many were stopped because it was not safe; settlers would come and massacre those who were participating. "They [settlers] would throw regalia in large bonfires…[people] even talk about how they impaled babies on sticks and roasted them around the fire, bashing their heads against trees…[People] talk about the rivers just being full of red blood. This is our history here locally." Participant 18 noted that the coming-of-age ceremony for girls was one of the first

ceremonies that was forcefully eliminated. Participant 17 noted that during this time period, some people believed that the ceremonies would be lost forever. To illustrate this concept, they described a recorded prayer where the term *'aawok*—an expression with a connotation of sadness—is used extensively in regard to the decision to end the ceremonies. "The saddest thing I ever heard," P17 said in reflecting on the prayer. Participant 5 characterized the later part of early contact as, "when your way of life becomes illegal," in regard to loss of access to traditional gathering and hunting sites due to federal and state laws applying to lands outside of the reservation. These experiences continue to color the way the Yurok see their relationships with settler institutions, such as conventional wildlife management. Indeed, collective memory, historical trauma, and historical trauma response processed through narrative are important in many Indigenous communities (Denham 2008).

The fourth phase began when the tide of Federal Indian Law changed and Yurok initiated efforts in self-determination and cultural revitalization, approximately in the 1970s. This phase continues to the present. Participant 14 explained that the Tribe is a relatively new formal governmental structure. As the contemporary tribal laws and courts take customary law into account for fisheries management, the Tribe is working to incorporate similar aspects into wildlife management. Participant 6 expressed empathy in that sometimes Yurok people today do not know cultural teachings, "It's not our fault that we don't know our language or rules that we once lived by. It's not our fault that we have to relearn all of this stuff."

A few participants noted that Yurok are currently in the process of revitalizing TEK and that despite living in the "White man's world," they still have their culture and are "passing it down." Participant 17 described the efforts in working with elders and others involved in revitalizing ceremonies such as the Brush Dance (*Kue' o melee'*), White Deerskin Dance (*Pyuueweg*), and Jump Dance (*Woneek 'we-legoo*). In the dances that they helped revitalize, they estimated the Brush Dance at 1 location had not taken place for 13 years, a White Deerskin Dance at 1 location for 90 years, a Jump Dance at 1 location for 75 years, and a Jump Dance at another location for 130 years. "I never wanted to see that happen again to where there was absence of ceremonies." Participant 14 noted, "It's important for us to preserve our traditional knowledge, ways of life…to preserve our identity as Yurok people: *Pueleeklaa oohl*, *Ner'ernerh oohl*. That's who we are."

The fifth phase is the future, as people made statements regarding future efforts in TEK and cultural revitalization and acknowledged that there will likely be continued changes in Yurok culture. For example, P20 expressed hope in revitalizing the Kick Dance (*Remoh*) at their ancestral village. Participant 9 noted, "I really hope that one of the benefits of your work is that we can begin to apply TEK to our landscape…it's been through hell but it's coming back. We [Yurok people] need to play a role." Participant 3 noted, "It's not like the old canoe days and all of that…50 years from now, today's going to be traditional…" Participant 14 said that Yurok people will need to find a new balance between the old ways and the present: "Times have changed. Times have evolved, and so we will evolve as a people, and our way of life will evolve to a certain degree."

Conceptualization of Yurok TEK

When asked explicitly what TEK is to them, participants held a range of familiarity with the term: 9 participants had never heard of TEK, whereas others had used it formally in meetings involving culture. Some noted that TEK is a new concept developed outside of Indigenous communities; P9 described the term as a "new buzzword in the intellectual community." Participant 1 noted, "TEK is actually new sounding to me even though I've been in the environmental field for over 10 years." Participant 2 said, "That word [TEK] really doesn't sink in that deep to me…Someone just got a name for it, but it's something that we've always done in practice and we still try to do that today." Participant 4 noted TEK is "…a coined term now and it really is a way of making Western science understand what Indians' values are…for an Indian person it's just thinking Indian. And, thinking about how you relate to your world and how wildlife and plants and everything else fits into that."

In 5 of the interviews, TEK was described as a "way of life." Traditional ecological knowledge is the avenue by which Yurok fulfill their identity and purpose, and knowledge transfer is important in this process. To illustrate, P14 stated, "This knowledge that they call ecological knowledge, that preserves our past. That's who we were, who we are, and who we're going to be…As a Yurok tribal member, I am charged with restoring balance and preserving the way of life, rebuilding, and to pass it on to our younger generations, so that we may dance until there is no more earth to dance on." Participant 18 stated, "It's that balance. That ecological knowledge is a balance of the world…" Some participants used science terminology to describe TEK. For example, P3 referred to TEK as ancient ecology and P5 spoke about the way of life, including customary laws (often referred to as Indian Law by Yurok) for survival and health of humans, wildlife, and the environment as components of traditional science.

Indeed, a major difference between Indigenous and Western conceptualizations of TEK concerns the fact that Indigenous knowledge is not regarded as just a system of knowledge but as a way of life that embodies this knowledge (Mazzocchi 2008). To many participants, the Yurok way of life, through TEK, includes spiritual and physical management in tandem (Figure 2). Participant 13 shared that TEK includes "…all of those things that make up how we keep the natural order and how we maintain those systems in terms of physical [and] spiritual management. And if they're not managed in a spiritual context, then the physical management is sort of irrelevant. Unfortunately, with the disciplines of [Western] science, we tend to manage the physical and leave the spiritual out." In P13's view, spirituality "has to be the foundation" of TEK.

Yurok TEK also includes the importance of knowing when and how to gather, hunt, harvest, and prepare traditional foods for the sake of survival. Maintaining the transfer of TEK from generation to generation ensures that if there was a disaster, "we could still survive because we know what we're supposed to do," as P17 noted. Participant 1 expressed similar sentiments: "It's how I was raised, both for survival and subsistence. What you take from the earth and how you live with the animals and how you survive by what you eat, what you gather, what you hunt, what you fish for. It's everything." Many spoke in terms of resource seasons and phenology. Participant 7 noted, "For me, traditional ecological [knowledge] is all the seasons…a certain timeframe of everything you know you need to gather." Participant 3 explained how coastal berry harvesting seasons indicate the beginning and end of surf fish (*Hehlkuesleg*; *Hypomesus pretiosus*) harvesting. Participant 20 used Yurok language to describe a

FIGURE 2 Yurok traditional ecological knowledge (TEK) can be expressed in the Yurok language as *hlkelonah'ue-megetohl* (to take care of the Earth), conceptualized as "a system where Yurok people and wildlife collaboratively strive to create and maintain balance of the Earth via physical and spiritual management in tandem" (Ramos 2019: 86). Physical management includes processes such as traditional burning for wildlife habitat management. Spiritual management can take place during ceremonies and can include the use of Yurok language. Although animals are taken for food, regalia, or tools, cultural protocols are intended to promote sustainable harvests

phenological cue: "They [frogs] always say, *'Ke'ween, ke'ween, ke'ween, ke'ween'*. That's 'Eels [*Lampetra tridentata*], eels'…my mom always told us when the frogs are making a lot of noise like that it's because the eels are going to run."

Several participants used the term system when discussing Yurok TEK and various aspects of the Yurok worldview and way of life. At the broadest level, there is an all-encompassing system of energy, explained by P13. There was a common sentiment that, at the physical level, Yurok people were intentionally placed in their ancestral lands and that they are a part of the system. Some participants used the term ecosystem. Further, Yurok people exist for the purpose of maintaining balance in the system by healing and renewing the earth. For example, P5 said that Yurok are "here to make our world balanced" and they "perfected a system" to do so. Participant 4 explained, "There's a balance to this world. That's a Yurok core value right there…that's what our ceremonies are based around, that's what our whole system is based around is a balance within our earth." Participant 13 noted, "We're fix-the-earth people. That's why we're put here." Balance also applies at the individual level: P19 said that the revitalization of language and ceremonies is very important because when they were lost during early contact, there was also a loss of the people because, "…ceremony is what balances us…It makes us a whole human being." If we are not able to have ceremonies, we become out of balance, "because that is what guides us and teaches us."

Participant 14 and P4 explicitly expressed that non-Indigenous people sometimes have difficulty understanding that Yurok are a part of the system. Participant 14 used a garden as a metaphor, with Yurok people as the gardeners. "What is a garden if you have no one to water it or to weed it or to harvest the fruit from it?" Participant 4 explained that many environmentalists strive to preserve natural resources, but in the Western perspective that means no human involvement, which is problematic for many Indigenous communities. "What they always fail to mention is that there's Indigenous people…For here it's Yurok, Tolowa, Karuk and Hupa and they completely take us out…if you're trying to manage a larger landscape you can't manage that without having Native people involved…you don't have these pristine, non-human-touched places. We were everywhere…Indians were everywhere and so there's always a managed landscape."

In addition to spiritual management via ceremony and physical management via active practices such as traditional burning and seasonal harvesting, TEK can be exercised via speaking the Yurok language and acquiring and singing traditional songs. Participant 14 explicitly noted songs and singing as a way of exercising TEK; songs are vital components of ceremony and traditional hunting. Participant 7 shared a story about how a good luck song came to a man who went hunting but, at first, did not encounter any deer. "This drum song came to him and he walked down the hill, killed a deer, and went and played card games and won all kinds of money with that song. So, it was not only hunting. He gathered something else up on the hill. He gathered a song that is still sung by his family." During the third time period expressed in interviews, when Indian children were forcefully sent to boarding schools, there was a loss of language use. Participant 19 noted that in losing the language, Yurok people also lose the essence of who they are. "You can look at the language and how it describes how to live and be in the world. It describes how to treat regalia…You see that connection between us and the environment. If we didn't have the language, we wouldn't have that."

Views on wildlife management

Discussions explicitly regarding wildlife management in the context of Yurok TEK spanned a wide range of topics. Several interview participants commented about landscape management, habitat management, and hunting. One participant described a job where his crew would leave tree snags for wildlife. Participant 4 noted, "I kind of think of it [wildlife management] more in a holistic way…it's a bigger worldview so even though they [Yurok people] were managing vegetation, at the same time they knew the science. They had traditional knowledge that if you manage the vegetation, you manage the forest, you burned, let certain plants grow here certain there, you kept prairies open, you had old growth—that benefited the wildlife." Participant 6 commented, "I think it's a thing that we have to

bring back: wildlife management. The Yurok people, they managed wildlife [a] long time ago and I think we haven't been doing that because we haven't had the power to do it. I think we need to manage the wildlife, like in creating wildlife habitat. Burning and stuff. That's what we used to do. Burn and it'd create food plots, natural food plots and it would increase everything. It got them [wildlife] to come closer. I think that's a big thing we need to do."

Several participants commented on the decline of wildlife such as elk and marten (*Wohpeyrokws*; *Martes caurina humboldtensis*) within Yurok jurisdiction and considered various management actions in addition to habitat management. Although some participants described the take of wildlife as dependent on the purpose and that one ideally should be permitted to take the number of animals they need, they also described cultural protocols to ensure wildlife populations were not overharvested. Participant 14 expressed that they had alternated hunting places to not take too many animals from one area. A few participants commented that forces outside of the Yurok community have caused wildlife populations to decline and to restore them, there should be limits on take until populations are healthy again. At least 1 participant suggested translocations of species to lands under Yurok jurisdiction as a management option. A few participants were also in support of formal management plans being developed by the Tribe.

There emerged a common sentiment that Yurok cultural values, in accordance with TEK, should be applied in the Tribe's wildlife management. For example, hunting was always discussed in terms of traditional hunting, changes in the way hunting has taken place in contemporary times or hunting for cultural purposes. Participant 16 noted, "We take life with discretion. It's our job to learn how to do it and how to take life, how to accept that life." A few participants commented on situations where animals might be considered problem animals and in those cases relayed that they did not believe there was justification for lethal removal. For example, P13 stated that animals, "… don't deserve to die just because they're doing what they naturally do." Similarly, P16 expressed, "That otter fella, he steals my fish out of my net all the time, but that's his job. He's trying to eat." Traditional hunting as management has been affected by changes in the landscape such that the traditional trail system is no longer intact. Participant 7 commented, "It's so brushy. It's so dense and thick and there's brush. You don't see them [wildlife]. That's why I think hunting evolved to driving around and waiting for it to rain, and at night. There's no place someone could go here and say, 'Okay, I'm going to go take a 4-mile walk up that hill on this trail.' On one of the old trails. You can't do that unless you go clear the trail."

Additional factors participants discussed in relation to TEK and wildlife management included community, education, and the importance of wildlife management to the continuance of TEK. Participant 14 noted, "Several things can happen to protect [wildlife]. One is to start off to educate our young people to respect life." Participant 4 commented, "But, you know you have to have more community involvement…it needs to be a community effort." Several wildlife species were discussed in terms of balancing the world via ceremony. As spirituality and ceremony are important to Yurok TEK, the role of wildlife becomes important. To illustrate, P4 stated, "Almost every ceremony that we have has a piece of wildlife in it. And, there's a whole process if you're gathering something that is going to be used in ceremony." It is important to take "into account animals and how they fit into our worldview."

DISCUSSION

In this research, the 7 tenets (Table 1) of IRM and social science qualitative methods that I applied complemented each other well. Rather than centering the methods solely on answering my research question, I sought to implement methods within IRM to provide space for considerations in cultural sensitivity as I engaged with the community. I was able to explore how TEK can be conceptualized through an Indigenous community's own cultural lens, and participants were able to express thoughts that extended beyond my focal question. The 7 tenets I applied in this research and actions I took to align with them, can be considered in a range of research scenarios. If one invests in understanding the fundamental aspects of an Indigenous research paradigm and IRM, then one can

choose whether IRM is an appropriate approach for a given project and appropriate methods for their circumstances and the community with which they are working (Wilson 2008, Kovach 2016).

Phases of time, community resilience, and TEK

As Indigenous history has largely been told from non-Indigenous worldviews (Mazzocchi 2008), it is important for Indigenous communities to tell their version of their stories (McGregor 2004). General phases of time, such as pre-human times and pre-European settlement, emerged as a prevalent theme in participants' narratives in this research. For Indigenous peoples, the practice of remembering is an important step in efforts toward decolonization. Indigenous communities must remember who they are, invest in learning their processes (including through stories), places, and people as they fulfill their vision and responsibilities. Some scholars have suggested that Westerners need to listen with an open mind to what Indigenous peoples have to say about themselves, their cultures, and knowledge (Mazzocchi 2008).

During pre-European contact, the majority of Indigenous communities in California relied on a hunter-gatherer subsistence economy, devoting much effort to actively managing their environment so that its ability to provide for food and material-culture needs was maximized (Anderson 2005). Most participants in this study noted drastic changes in Yurok way of life and how Yurok people must operate in the world today. The effect of European colonization continues to reverberate through the collective psyche of the Yurok community. My study demonstrates that despite traumatic historical events since contact with European settlers, and in a modernized world, Yurok have maintained a distinct cultural identity and relationship with wildlife. This aligns with historical trauma response in Indigenous communities that has been shown to include resilience (Denham 2008).

There is resilience in the Yurok community through the maintenance and revitalization of TEK. In research with Indigenous communities, historical and cross-generational trauma, poverty, isolation, and powerlessness need to be considered, but researchers should not portray Indians largely as victims of history (Champagne 2015). The community is reeling from traumatic historical experiences and contending with how to heal and sustain culture while also managing natural resources under a formal tribal governmental structure and in partnership with other organizations and agencies. The participants indicated hope for the future in sentiments regarding the application of TEK in landscape management. Because of the experiences of Yurok people during early contact and present efforts in cultural revitalization, participants had a strong desire to share their TEK for future generations of Yurok people and promote cultural sensitivity in relationships between the Tribe and other entities. Rather than using cautionary language, most participants expressed views of this research as an opportunity to facilitate cultural survival.

Conceptualization of Yurok TEK

Literature regarding the philosophies and definitions of TEK and how it compares and relates to Western approaches is extensive, with areas of overlap and separation noted (Whyte 2013, Ramos 2018). If researchers wish to bridge gaps between Indigenous and Western paradigms, it might be helpful to understand tribal worldviews as related to TEK (Champagne 2015). Some scholars have strongly discouraged extracting aspects of TEK (i.e., empirical observations) to include in scientific research and thus disassociating them from the worldviews and cultural values from which they come. To do so misrepresents the knowledge systems and imposes a framework that may not be consistent with the local paradigm. Therefore, it is recommended to prioritize the identification of cultural values and associated practices (McMillen et al. 2014). In this research, several themes were revealed as important in TEK through the Yurok cultural lens such as the conceptualization of TEK as a system with various components, the relationship between people and wildlife in Yurok TEK, and the importance of language in Yurok TEK.

In the Yurok worldview, the purpose of Yurok people is to balance the world and the concept of humans as part of the system is built into their TEK. Several interview participants used the term system to describe TEK and how Yurok people relate to the environment. Yurok TEK can be conceptualized as, "a system where Yurok people and wildlife collaboratively strive to create and maintain balance of the Earth via physical and spiritual management in tandem" (Ramos 2019: 86). Practicing TEK through this system also creates opportunities for knowledge sharing, one of the themes that emerged in this research. Several participants noted that spirituality is a fundamental element of Yurok TEK. One participant noted that if the system is not managed in a spiritual context, then the physical management is irrelevant. Similarly, it has been written in TEK literature that purely ecological aspects of tradition cannot be separated from the social and spiritual (Berkes 2012). Social institutions, such as ceremony, provide ties to a time when the system was managed in an effective and integrative state and may illuminate a future where cohesion can be found again. Ceremony reaffirms for Yurok that it is their purpose to fix the Earth by striving for balance, which includes taking care of the ecosystem and wildlife via TEK. This interpretation of Yurok TEK aligns with literature that states many Indigenous communities have a philosophical basis for achieving well-being for humans and the environment (Caillon et al. 2017).

Results of this study indicate that Yurok community members might not use the term TEK; rather, what academia calls TEK is considered to simply be a way of life that includes science. Traditional ecological knowledge has been described in the literature as a branch of Indigenous science (Snively and Corsiglia 2001, Ramos 2018). The framing of TEK as a way of life is consistent with explanations of TEK by some Indigenous scholars (McGregor 2004). That some participants in this study had never heard the term TEK speaks to a potential disconnect between the academic field of TEK and the lived experiences of some Indigenous communities, as the term TEK is often used in reference to Indigenous communities.

Human-wildlife relationship in Yurok TEK

Participants' views of wildlife were characterized by connections to various aspects of culture and community. When wildlife are taken for food or regalia, the items are often shared amongst community. For example, an elk might be taken to feed people at a ceremony. The values of sharing and reciprocity for distribution of resources (McMillen et al. 2014) were exemplified by the participant who described sharing deer meat with their community and then went home with nothing for themselves. This story also demonstrates the importance of cultural values in TEK.

A culture's worldview mediates its interconnected set of TEK, social networks, and social institutions (Turner and Berkes 2006). From a Yurok cultural perspective, this interconnectedness is exemplified with wildlife in TEK. Wildlife participate in ceremony via incorporation in regalia and subsequent investment of their spirit. Wildlife also have an important place in the establishment of traditions and teachings through traditional Yurok stories (e.g., the *woogey* times). Further, teachings are learned from direct observations of wildlife and those teachings may be shared during ceremony. In these ways, wildlife are said to teach the Yurok people. Wildlife participate as regalia and provide teachings for how to relate to the environment; ergo, we can begin to conceptualize the relationship between take of animals for food and ceremony, the practice of ceremony, and conservation in the Yurok system of creating balance.

Yurok language and TEK

Several interview participants noted the importance of language in Yurok TEK, as language is one way that people understand and express their worldviews. Further, there has been a considerable effort to revitalize the Yurok language from near complete loss. Some participants spoke in the Yurok language during their interview. Not only can it be difficult to convey concepts and values from one language and culture to another, but it can also be difficult to achieve congruence in meaning of the same language and terms (Mazzocchi 2008). This is exemplified in

what is perhaps one of the most perplexing results of this research; there is no word or concept for wildlife in the Yurok language that has the same meaning as commonly used in the wildlife profession. The Yurok language is a verb-based language; even the numerals and color terms are verbs and change form depending on the meaning they are applied to (e.g., a different form of 2 is used for snakes and human beings). This is how Yurok organizes its phenomena in the world (Garrett 2014). Although there exist general categories such as animal (*hoore'mos*) and small bird (*ch'uech'eesh*), it is generally said that everything has its own name and should be referred to accordingly.

Some scholars have suggested that, to be understood, terms and meanings should not be isolated from but considered within the terminological and semantic frameworks of their cultures. Dialogue can facilitate cross-culturally shared meanings (Mazzocchi 2008). For example, I held an informal discussion about TEK with Yurok language teachers and learners at a Yurok language camp. I explained concepts that I had read in the literature and that had emerged in my research. I invited others to share their perspectives of TEK. I then asked how TEK can be expressed through a Yurok worldview in the Yurok language. There was explicit discussion surrounding the concept of land and the Earth as having physical and spiritual attributes. Over the course of the discussion, we concluded that "*hlkelonah 'ue-megetohl*" (to take care of the Earth) would encompass the general paradigm of Yurok TEK.

The future of TEK in wildlife management and conservation

Cultural longevity depends on the ability to sustain cultural knowledge, and many Indigenous scholars emphasize methodological approaches that respect cultural knowledge (Kovach 2016). Tribal communities may prefer interpretations of TEK that reflect their own worldviews and the interconnectedness of social relations, culture, language, and relationships with the nonhuman world, such as with animals and the cosmos. Indigenous communities, while often critical of research practices and assumptions, do not always necessarily reject Western science. Western scientific research methods are acceptable as long as the researchers are respectful of tribal culture, understand the history of and efforts toward tribal sovereignty, are familiar with Indigenous worldviews, and demonstrate that their motives are in the best interest of the tribal community (Champagne 2015).

Potential application of the concepts shared in this paper may include the areas of biocultural conservation (Caillon et al. 2017) and human dimensions of wildlife management (Decker et al. 2012). Previous researchers have demonstrated links between TEK and sustainable resource use (Bird et al. 2012), lending interest in biocultural approaches that ground management in local knowledges, practices, and ontologies. These approaches encompass the biological and cultural aspects of a system and address complex relationships and feedbacks within human and ecological well-being. Additionally, such approaches reinforce a "people as part of nature" perspective (Caillon et al. 2017). Wildlife management can be approached as a complex undertaking that requires a mix of technical and value judgments, supported by social science and stakeholder engagement processes. The field of human dimensions of wildlife emerged, in part, to give inclusive perspective with attention to stakeholders. Human dimensions of wildlife management includes considerations about individuals, groups, social structures, cultural systems, and institutions (Decker et al. 2012). Though this paper does not prescribe specific instructions for other researchers and Tribes, the general principles may be relevant in various regions around the world. Opportunity exists to chart new academic, professional, and career trajectories that promote and facilitate interdisciplinary approaches in scientific disciplines, with consideration of TEK and IRMs.

MANAGEMENT IMPLICATIONS

This research can be used in support of the efforts of organizations such as the Native Peoples' Wildlife Management Working Group of The Wildlife Society, Native American Fish and Wildlife Society, American Indian Science and Engineering Society, Society for Advancement of Chicanos/Hispanics and Native Americans in Science,

and the TEK section of the Ecological Society of America. This research also provides fertile ground for understanding human-wildlife relationships within a TEK context, and then taking this knowledge into account in culturally sensitive wildlife research. With continued work in this trajectory, we might begin to see opportunities that were previously not evident for conducting wildlife research and management within an integrated context—inclusive of both Indigenous and Western scientific paradigms—that is beneficial for humans and wildlife.

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ETHICS STATEMENT

I conducted interviews approved by The University of Arizona Human Subjects Protection Program and Institutional Review Board (IRB 1000000334).

DATA AVAILABILITY STATEMENT

Research data are not shared.

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